

Construction of exact solutions to the Muskat problem

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Abstract

A modification of Howison's method is proposed to construct exact nonstationary solutions of the unsteady two-phase Hele-Shaw problem (Muskat problem). The effectiveness of the modified method is demonstrated by reproducing D. Crowdy's exact solution for the evolution of an elliptic bubble of a viscous fluid surrounded by another fluid in an unbounded Hele-Shaw cell. This solution is found to be directly related to the explicit solution of the single-phase Hele-Shaw problem. A comparison of these solutions shows that allowance for the second phase leads to a weak regularizing effect: the single-phase solution exists over a finite time, while the two-phase solution exists over an infinite time under the same initial conditions. © 2011 Pleiades Publishing, Ltd.

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Keywords

elliptic bubble, Muskat problem, unsteady two-phase Hele-Shaw problem